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## Panel and panel fastening system

5    5.1 The invention relates to a fastening system for panels, in particular for floor panels, whose narrow sides are provided with retaining profiles, wherein mutually opposite retaining profiles of a panel match each other in such a way that similar panels can be fastened to one another.

For the purposes of laying panels on floors or for mounting panels to  
10 other surfaces of a building, fastening systems are known, which are based on a groove-and-tongue fastening system and in which the groove is provided with an undercut configuration in which the tongue can be secured in such a way that they cannot be separated from each other by pulling two interconnected panels away from each other in the plane in  
15 which they are laid.

There is the disadvantage here that only relatively slight undercut configurations can be afforded as otherwise the groove and the tongue can be only poorly fitted one into the other. Those slight undercut configurations only afford a good retaining action if the connected retaining  
20 profiles are of a sufficient length and the load can thus be distributed over the entire length of the panel. The known retaining profiles based on a tongue and groove arrangement are consequently only poorly suited to the short narrow sides of a panel.

A further disadvantage is that a groove-and-tongue connection of  
25 undercut configuration, which can only be assembled and separated by elastic deformation of the retaining profiles, suffers rapid wear after having been laid a plurality of times. Admittedly, further laying is possible in the worn condition, but the retaining profiles wear out and the arresting function deteriorates.

30 Therefore the object of the invention is to provide a fastening system which is of a simple design configuration and which is more durable than the known fastening systems.

In accordance with the invention that object is attained in that at  
least one pair of oppositely disposed retaining profiles has complementary  
35 hook elements which can be hooked one into the other and that the hook

elements are provided with retaining surfaces by means of which the panels are held against each other in the assembled condition in such way that a gap-free floor surface is afforded.

5 The durability of the fastening system is markedly enhanced by the simple measure of replacing the slight undercut configuration of the known fastening system by extended hook elements. The success of the invention is afforded when at least the short narrow sides of the panels are provided with the proposed hook elements.

10 The hook elements make it possible to achieve a degree of undercut which is approximately a third of the total panel thickness. In this respect, the way in which the short narrow sides of the panels are locked together in itself recalls roof tiles which engage laterally one behind the other.

In the case of the known groove-and-tongue connection only one of two groove walls involves an undercut configuration. The corresponding side of the tongue engages therebehind and affords a retaining effect. The other groove wall and the corresponding side of the tongue do not afford any retaining action. In comparison the fastening system according to the invention has two hook elements which engage one into the other and it is possible to forego a second groove wall without any undercut.

20 In *Fig. 2* C 2 In a simple manner a first retaining profile of a panel is provided with a hook element formed from a leg which projects approximately perpendicularly from the narrow side and which is arranged at the top side of the panel, wherein arranged at the free end of the leg is a hook projection which faces towards the underside of the panel. The rear retaining profile of the panel is provided with a hook element formed from a leg which projects from the narrow side and which is arranged at the underside of the panel, wherein arranged at the free end of said leg is a hook projection which faces towards the top side of the panel.

30 The top side of the panel forms a transition into the leg from the region involving the thickness of the complete panel, with a step in respect of the thickness of the panel. The leg is approximately of a thickness which corresponds to a third of the thickness of the panel. The same applies to the underside of the panel. In opposite relationship to the hook element of

the top side, the leg at the underside forms a transition into the leg from the region of the complete thickness of the panel, with a step in respect of the panel thickness, the leg also being of a thickness which is about a third the thickness of the panel. The legs and the hook projections are substantially more massive than the undercut configuration of the known groove-and-tongue connection. That therefore involves an improvement in the strength and durability of the fastening system according to the invention.

C3 Advantageously the hook projection of the leg at the underside bears in the assembled condition of a panel against the leg at the top side of a second panel. In addition clearance is provided between the hook projection of the leg at the top side of the second panel and the leg at the underside of the first panel.

It will be appreciated that this can also be reversed so that clearance can be provided between the hook projection of the leg at the underside of the first panel and the leg at the top side of the second panel. What is important is that a pair of leg/hook projection, in the assembled condition, always bear clearly against each other, and the other leg/hook projection pair has clearance therebetween. If the fastening system were so designed that both leg/hook projection pairs always bear against each other, then tolerances in manufacture of the retaining profiles mean that well-defined contact therebetween would not be achieved and sometimes one leg/hook projection pair and sometimes another leg/hook projection pair would bear against each other.

C4 A development of the fastening system provides that the retaining surfaces of the hook projections engage behind each other in such a way that complementary hook projections can be hooked one into the other only by elastic deformation. The panels are thus arrested perpendicularly to the plane of laying thereof.

It is possible in that way to ensure that the retaining elements cannot be moved away from each other for example due to an uneven base, when subjected to a loading. When a panel is subjected to a loading,

the connected panel is moved with the loaded panel in the same direction. The join remains together.

C5 In a simple manner the retaining surfaces of the hook projections are inclined and the hook projections are reduced from their free ends towards the legs. In addition the retaining surfaces of complementary hook projections bear snugly against each other at least in a region-wise manner. This involves a simple design configuration for the hook projections which are provided with an undercut configuration, because a flat retaining surface which can be easily produced is provided as the undercut configuration.

C6 A further advantage is achieved if the end of the hook projection at the top side of the one panel in the assembled condition bears at least in the region of the top side of the panel against the second panel and clearance is provided between the hook projection at the underside of the second panel and the end of the first panel. That measure again serves to provide that there is always a clear condition of contact between two connected panels, by virtue of the structural configuration involved.

C7 An alternative embodiment provides that at least one of the ends of a hook element of a panel has at its free end a projecting detent or latching element which in the assembled condition engages into an undercut recess of the hook element of the other panel.

This structure has been found to be particularly good to handle because the retaining profiles can be latched one into the other under light pressure and with elastic deformation. In addition the hook elements enjoy good resistance to wear, which is advantageous in terms of multiple laying. The resistance to wear is good for the reason that different arresting functions are performed by different hook element regions and the loading on the hook element thus occurs in a distributed fashion. The panels are arrested for example by the detent element and the recess, perpendicularly to the plane in which the panels are laid. In contrast, the arresting action for the panels to prevent them from being pulled apart in the longitudinal direction thereof is afforded by the retaining surfaces of the hook projections.

C8 In a simple manner the projecting detent element of the first panel is in the form of a bead which extends over the entire length of the narrow side and the undercut recess of the second panel is in the form of an elongate channel which receives the bead in the assembled condition. To form the join the bead and the channel have to be fitted one into the other with elastic deformation of the hook elements.

This embodiment of the fastening system is particularly suitable for multiple laying, when no glueing is effected, by virtue of its resistance to wear. It is also inexpensive to manufacture.

10 In the region of the join an clearance gap can be tolerated between the panels at the underside of the panels which are laid on a support base, for example a floor finishing layer.

C9 A further improvement provides that the regions provided with clearance in the assembled condition of two panels form adhesive pockets. Besides use of the proposed fastening system for adhesive-free laying of floor panels, it is particularly suitable for making a join with adhesive.

For that purpose those locations of the retaining profiles, which have to be provided with adhesive, are identified for example in instructions for use or by markings on the retaining profile itself. In that way, the user can apply adhesive very accurately where adhesive pockets occur in the assembled condition of two panels.

20 In the predominant situations of use of the floor panels the glued form of laying same is considered to be the most appropriate fashion of laying the panels. That is because the durability of the panels is markedly improved. Securing the retaining profiles by adhesive provides that dirt and moisture are virtually prevented from penetrating into the joins. The absorption of moisture and swelling of the panels in the join region of the retaining profiles is minimised thereby.

It will be appreciated that there can be situations of use for which adhesive-free laying is to be preferred. For example, when a floor covering when laid has to be frequently taken up again and re-laid, for example when dealing with floors in setting up fairs and exhibitions.

C10 An embodiment which is simple and durable has been found to be a structure in which the retaining profiles of the long narrow sides are in the form of complementary positively engaging profiles, wherein the positively engaging profile of one panel forms a common hinge with the complementary positively engaging profile of a second panel in the laid condition and the hinge is to be assembled by a rotary joining movement of the panels. By virtue of that pivotability between the long narrow sides, that connecting location between the panels is protected from severe material damage and breakage of the retaining profiles.

By virtue of the presence of the hinge the panels can be bent upwardly and downwardly at the connecting location. If for example a panel is resting on a support base with a raised portion so that when a loading is applied a narrow side of the panel is pressed on to the support base and the oppositely disposed narrow side rocks upwardly, then a second panel which is fastened to the upwardly moving narrow side is also moved upwardly. The flexural forces which are operative in that situation however do not damage the narrow cross-sections of the positively engaging profiles. Instead a pivotal movement takes place. This structure takes account of the principle of 'matched deformability'. That principle is based on the realisation that very stiff and accordingly allegedly stable connecting locations give rise to high levels of notch stresses and easily fail as a result. In order to avoid this, components are to be designed in such a way that they have 'matched deformability' or flexibility which is suitably adapted to the purpose of use, and in that way notch stresses can be reduced.

A floor laid with the proposed fastening system has a flexibility which is adapted to irregular rough or corrugated base surfaces. This measure therefore enhances the durability of the panels. The fastening system is therefore particularly well suited for panels for renovating irregular floor surfaces in old buildings.

Even in the case of a flat base panels can suffer from an alternate flexing effect, more specifically if a soft underlay, for example a sheet for deadening the sound of footsteps, or the like, is laid on the base. At a

loaded location the underlay is depressed and the panels flex at their connecting locations. The fastening system is also better suited for this kind of panel laying than the known fastening systems.

5 A further advantage is that panels with the fastening system according to the invention are better suited to multiple laying than panels with the known fastening system because the panels with the fastening system according to the invention, even after a long period of use on an irregular base, do not have any early signs of damage to the positively engaging profiles. The positively engaging profiles are stable in respect of  
10 shape and durable. They can be used for a substantially longer time and can be re-laid more frequently because of their service cycle.

C11 In a simple embodiment the hinge is formed from an opening in the narrow side of the first panel and a matching projection on the complementary narrow side of the second panel. The positively engaging  
15 profiles are preferably of such a design that a loading at the top side of the floor panels in the laid condition is transmitted from the top wall of the opening in a first panel to the projection of the second panel and from the projection of the second panel to the wall at the underside of the first panel. In the laid condition, the walls of the opening in the first panel are in  
20 contact with the top side and the underside of the projection of the second panel. The top wall of the opening however is in contact with the projection of the second panel only in a short region at the free end of the upper wall of the opening. In that way the structure permits a hinge movement between the panel with the opening and the panel with the projection, with  
25 slight elastic deformation of the walls of the opening. In that way the stiffness of the connection is best matched to an irregular base which inevitably results in a bending movement between panels which are fastened to each other.

C12 In a simple structure the hinge is formed from a concave  
30 curvature in the inward wall of the opening which is towards the base, and a convex curvature at the underside of the projection, which is towards the base. In addition the top side of the projection of a panel, which is remote from the base, has an inclined removal of material which extends to the

free end of the projection. The thickness of the projection is increasingly reduced towards the free end by the removal of material. A free space for movement is afforded for the common hinge by the removal of material.

In order to take up laid panels again, desirably firstly a row of panels  
5 disposed in mutually juxtaposed relationship are lifted in such a way that they rotate inclinedly upwardly in the hinge. The projections are then pulled in an inclined direction out of the openings and the hinge is taken apart. The panels are then only joined at the short narrow sides. It is recommended that the interengaged hook elements of the short narrow  
10 sides should be pulled apart in their longitudinal extent, in order in that way in the disconnection procedure to avoid deformation of the hook elements, such as to cause material fatigue.

C13 Advantageously the convex curvature of the projection and the concave curvature of the opening substantially form a portion of a circle,  
15 wherein the centre point of the portion of the circle is on or beneath the top side of the projection in the laid condition. In the latter case the centre point of the circle is within the cross-section of the projection.

This simple design configuration affords a hinge in which the convex curvature of the projection is similar to a hinge ball and the concave  
20 curvature of the recess is similar to a hinge socket, in which respect as will be appreciated, unlike a ball-and-socket joint, no spherical movement but only a straightforward rotational movement is possible.

C14 In an advantageous development the furthest projecting point of the convex curvature of the projection of a panel is so arranged that it is  
25 somewhat below the upper edge of the panel. That means that the projection is of a cross-section which is relatively large in comparison with the overall thickness of the panel. In addition the concave curvature of the opening affords a sufficiently large undercut configuration for the convex curvature of the projection so that they can scarcely be moved away from  
30 each other by virtue of the tensile forces acting in the plane in which the panels are laid.

C15 The hinge properties of two interconnected panels can be further improved if the wall of the opening of a panel, which is towards the base,



has on its inside an inclined removal of material which extends to the free end of the wall and the wall thickness of said wall is increasingly thinner towards the free end. In that case a free space for movement for the common hinge is provided by the removal of material, in the laid condition  
5 of two panels.

With that improvement, the amount of elastic deformability of the walls of the opening is further reduced, during flexing of the laid panels in an upward direction.

C16 It is also desirable if the opening of a panel can be enlarged for  
10 connection to the projection of a further panel by resilient deformation of its lower wall and the resilient deformation of the lower wall which occurs during the joining operation is reversed again in the finished joined condition of two panels. In that way the positively engaging profiles are elastically deformed only for the joining operation and during a pivotal  
15 hinge movement and are not subjected to any elastic stressing when they are not loaded.

C17 Preferably the positively engaging profiles are formed integrally at the narrow sides of the panels. The panels can be produced very easily and with a low level of waste.

20 C18 It has been found that the strength of modern carrier materials such as for example medium density fibreboard (MDF) or high density fibreboard (HDF) which are provided with a wear-resistant working layer are particularly suitable for use of the fastening system proposed. Those materials are simple to machine and achieve adequate surface quality, for  
25 example by a cutting machining operation. In addition those materials enjoy high stability in respect of shape of the milled profiles. Even after having been laid a plurality of times the retaining profiles are still so good in terms of shape that a secure join is possible, even on an uneven base.

C19 A further advantage is afforded if in the laid condition of the  
30 panels the free spaces for movement for the common hinges are provided with a filler which hardens in soft-elastic form. That filler preferably closes all joins and in particular the join at the top side, in such a way that no moisture and no dirt can penetrate. Upon a hinge movement of the

interconnected panels the soft-elastic filler is squeezed or stretched, depending on the direction of rotation of the hinge movement. In that situation it always adheres to the contact surfaces of the narrow sides of the panels and returns to its initial shape upon return of the hinge  
5 movement. The filler contributes to the return movement of the hinge, by virtue of the elastic internal deformation of the filler. .

The invention is described in greater detail hereinafter with reference to the Figures and illustrated by way of example in a drawing in which:

Figure 1 is a diagrammatic side view of a laid floor covering  
10 comprising panels with the fastening element according to the invention with hook elements,

Figure 2 is a side view of part of an embodiment of the fastening system with hook elements,

Figure 3 is a side view of part of a further embodiment of the  
15 fastening system with hook elements,

Figure 4 is a diagrammatic view of a retaining profile with a leg at the underside and showing the machining tools for producing the undercut configuration,

Figure 5 shows an embodiment of the fastening system with hook  
20 elements which can be fixed by way of a retaining element,

Figure 5.1 shows an embodiment of the fastening system with hook elements which can be fixed by way of two retaining elements,

Figure 6 is a view of a part of a fastening system with complementary positively engaging profiles which in the assembled  
25 condition of two panels form a hinge,

Figure 7 shows the fastening system of Figure 6 in the assembled condition,

Figure 8 shows a joining operation with panels as shown in Figure 6, in which the projection of one panel is fitted in the direction of the arrow  
30 into the opening in the second panel and the first panel is then arrested with a rotary movement,

Figure 9 shows a further joining operation with panels as shown in Figure 6, in which the projection of the first panel is inserted in parallel relationship with the laying plane into the opening in the second panel,

Figure 10 shows the fastening system in the assembled condition as shown in Figure 7, wherein the common hinge is moved upwardly out of the laying plane and the two panels form a kink,

Figure 11 shows the fastening system in the assembled condition as shown in Figure 7, wherein the hinge is moved downwardly out of the laying plane and the two panels form a kink, and

Figure 12 shows a fastening system with panels as shown in Figure 6 in the laid condition of two panels with a filler between the positively engaging profiles of the long narrow sides.

Referring to Figure 1 of the drawing a floor covering 1 with the proposed fastening system 2 is composed of a plurality of similar panels 3, 4, 5 and 6. The first panel 4 has at mutually opposite narrow sides mutually matching retaining profiles 4a and 4b with complementary hook elements 4c and 4d. In that way it is always possible for a first retaining profile 4a to be joined to a second retaining profile 5b of a second panel 5.

Figure 2 shows a side view on an enlarged scale of a portion of an embodiment of the fastening system 2. Figure 2 shows a first retaining profile 4a of a panel 4 with a hook element 4c which is formed from a leg 4e which projects substantially perpendicularly from the narrow side and which is arranged at the top side 6 of the panel. In this case a hook projection 4f which faces towards the underside 7 of the panel 4 is arranged at the free end of the leg 4e. The hook projection 4f is in engagement with a hook projection 5f of a second panel 5. The hook projection 5f of the second panel 5 forms the retaining profile of the rear narrow side. It is also formed from a leg 5e which projects from the narrow side of the second panel 5 and is arranged at the underside 8 of the second panel 5. The hook projection 5f is also arranged at the free end of the leg 5e and faces towards the top side 9 of the panel 5. The hook projections 4f and 5f of the two panels 4 and 5 are hooked one into the other.

The hook projection 5f of the second panel 5 with the leg 5e at the underside bears in the assembled condition of the first panel 5 against the leg 4e at the top side of the second panel 4. For the purposes of affording well-defined contact clearance L1 is provided between the hook projection 4f of the leg 4e at the top side of the first panel 4 and the leg 5e at the underside of the second panel 5 in the present embodiment.

As shown in Figure 2 retaining surfaces 4g and 5g of the hook projections 4f and 5f engage one behind the other in such a way that the hook projections 4f and 5f can be hooked one into the other only by elastic deformation. Formed between the inside surface 10 of the hook profile of the second panel 5 and the oppositely disposed retaining surface 4g of the hook projection 4f is an opening 11 which at its narrowest location is of a width a. That is less than the width b of the hook projection 4f of the first panel 4 at its widest location. By virtue of that configuration and due to elastic deformation when joining the hook projections 4f and 5f, the complementary hook projections 4f and 5f involve a snapping engagement into a defined end position. In the present embodiment the retaining surfaces 4g and 5g of the hook projections 4f and 5f are kept simple and are in the form of inclinedly disposed flat surfaces. They decrease from the free ends of the hook projections 4f and 5f towards the legs 4e and 5e. In the present embodiment, as can be seen in Figure 2, the retaining surface 4g of the hook projection of the first panel 4 is rounded off at the upper and the lower ends. The same applies for the retaining surface 5g of the hook projection 5f of the second panel 5. That promotes interengagement of the hook projections 4f and 5f insofar as, during a joining movement which is perpendicular to the plane in which the panels are laid, the retaining profiles 4a and 5b are slowly elastically spread open. That facilitates the laying procedure and protects the retaining profiles 4a and 5b.

The retaining surfaces 4g and 5g, which bear against each other, of the co-operating panels 4 and 5 therefore bear snugly against each other in a region-wise manner. The resulting intermediate spaces can advantageously serve as adhesive pockets 12.

Clearance L2 is further provided between the end 5h of the hook projection 5f at the lower side of the second panel 5 and the inside surface 13 of the first panel 4. That resulting intermediate space can also serve as an adhesive pocket 12. The same applies in regard to the end 14 of the hook projection 4f at the top side of the first panel 4 which in the assembled condition bears against the second panel 5 at least in the region of the top side 6 and 9 of the panels. In the present embodiment, an intermediate space which is also in the form of an adhesive pocket 12 is enlarged beneath the top sides 6 and 9 of the panels towards the interior of the join.

A second embodiment of a fastening system 2 is shown in Figure 3. Therein the same technical features are denoted by the same references as in Figure 2. The embodiment of Figure 3 differs from the embodiment of Figure 2 in that that one of the two leg/hook projection pairs which bears one against the other and that which has an air gap or clearance have changed. The fundamental function of the fastening system 2 still remains the same. The arrangement once again involves well-defined contact between the hook projections 4f and 5f and a gap-free surface for the floor covering 1.

Finally Figure 4 shows a diagrammatic view of a panel 5 with a retaining profile 5b according to the invention. The Figure diagrammatically shows how the undercut contour of the retaining projection 5f can be produced by means of two cutting tools W1 and W2 which rotate about the axes X1 and X2. The tools W1 and W2 produce an opening 15 in which a complementary hook projection of a further panel (not shown) can be hooked in detent relationship.

Figure 5 shows an alternative embodiment of a fastening system with particular complementary retaining profiles 20 and 21 at the short narrow sides of panels 22 and 23. Once again the arrangement has hook elements 24 and 25 which, like the foregoing embodiments, have legs 26 and 27 as well as hook projections 28 and 29. The embodiment of Figure 5 is so constructed that the end 30 of the hook element at the underside of the second panel 23 has at its free end a projecting detent element 31

which engages into a recess 32 of undercut configuration in the hook element 24 at the top side of the first panel 22. The hook elements 24 and 25 can be latched one into the other by a slight pressure and with elastic deformation. The panels 22 and 23 are arrested perpendicularly to the plane of laying thereof by the detent element 31 which engages into the recess 32. The action for arresting the panels 22 and 23 to prevent them from being pulled apart in the longitudinal direction thereof is afforded by retaining surfaces 33 and 34 which are provided on the hook projections 28 and 29 of the hook elements 24 and 25.

Figure 5.1 shows a further embodiment which is based on the embodiment of Figure 5. In this respect identical features in those two Figures are denoted by the same references. In comparison with the embodiment of Figure 5 the embodiment of Figure 5.1 is designed in such a way that the end 35 of the hook element 24 at the top side of the first panel 22 has at its free end a projecting detent or latching element 36 which engages into a recess 37 of undercut configuration in the hook element 25 at the underside of the second panel 24. In order to latch the hook elements 24 and 25 a somewhat greater pressure has to be applied than in the embodiment of Figure 5. The panels 22 and 23 are arrested more firmly than in the embodiment of Figure 5 by the detent element 31 engaging into the recess 32 and the additional detent element 36 engaging into the recess 37. The projecting detent elements 31 and 36 respectively of the panels 22 and 23 are in the form of beads or ridges which extend over the entire length of a narrow side. It will be appreciated that, instead of a bead on a hook projection, it is also possible for example to provide a projecting nose having a bevel (not shown), with the bevel of the nose being so oriented that, with increasing progress in the joining operation, the corresponding hook element is gently expanded. The recesses 32 and 37 of undercut configuration in the panels 22 and 23 are in the form of elongate channels which receive the beads in the assembled condition. The bead and the channel can be milled by so-called formatting in a production pass. For the purposes of joining the panels 22 and 23 a bead and a channel have to be fitted one into the other with elastic deformation of the

hook elements 24 and 25. In addition the embodiments of Figures 5 and 5.1 differ in terms of the co-operation of the legs 26, 27 and the hook projections 29, 28. As shown in Figure 5 the leg 26 bears against the hook projection 29 and clearance is provided between the hook projection 28 and the leg 27. As shown in Figure 5.1 clearance is provided between the leg 26 and the hook projection 29 and the hook projection 29 bears against the leg 27.

Figure 6 illustrates a fastening system for rectangular panels 40 and 41. At their long narrow sides the panels 40 and 41 have retaining profiles in the form of positively engaging profiles 42 and 43. The mutually opposite positively engaging profiles 42 and 43 of a panel 40 and 41 respectively are complementary to each other. In that way it is possible to fit to each panel which has already been laid a further panel.

The positively engaging profiles 42 and 43 in Figure 6 are based on the state of the art of German utility model No G 79 28 703 U1. In particular on the positively engaging profiles of the embodiment which is disclosed in Figures 14, 15 and 16 and in the related part of the description of G 79 28 703 U1. The positively engaging profiles 42 and 43 of the present fastening system are the subject of further development in relation thereto in such a way that they permit hinged and flexible connection of panels 40 and 41 which make the fastening system more durable and assist with frequent re-use.

One of the positively engaging profiles 42 is provided with a projection 44 which protrudes from a narrow side. The underside of the projection 44 which in the laid condition is towards the base has a cross-section with a convex curvature 45, for the purposes of affording a hinged connection. The convex curvature 45 is rotatably mounted in the complementary positively engaging profile 43. In the illustrated embodiment the convex curvature 45 is in the form of a portion of a circle. The part of the narrow side of the panel 42, which is arranged beneath the projection 44 and which in the laid condition is towards the base, is further back from the free end of the projection 44 than the part 47 of the narrow side, which is arranged above the projection 44. In the illustrated

embodiment the part 46 of the narrow side, which is arranged beneath the projection 44, is set back approximately twice as far from the free end of the projection 44 as the part 47 of the narrow side, which is arranged above the projection 44. The reason for this is that the circular portion of the convex curvature 45 is relatively wide. In that way the furthest projecting point of the convex curvature 45 of the projection 44 is so arranged that it is somewhat beneath the top edge 48 of the panel 40.

The part 47 of the narrow side, which is arranged above the projection 44, projects at the top side of the panel 40 from the narrow side and forms a joint abutting surface 49. The part 47 of the narrow side is set back between that joint abutting surface 49 and the projection 44 of the panel 40. This ensures that the joint abutting surface 49 with the joint abutting surface 39 of the complementary panel 41 always forms a closed join at the top side.

The top side of the projection 44, which is in opposite relationship to the convex curvature 45 of the projection 44, has a short straight portion 50 which in the laid condition is also arranged parallel to the base U. From that short portion 50 towards the free end the top side of the projection 44 has an inclined removal of material 51 which extends to the free end of the projection 44.

The positively engaging profile 43 which is complementary to the above-discussed positively engaging profile 42 is discussed hereinafter with reference to the panel 41. The positively engaging profile 43 has an opening 52. It is substantially delimited by a lower wall 53 which in the laid condition is towards the base U and an upper wall 54. On the inside of the opening 52 the lower wall 53 is provided with a concave curvature 55. That enjoys the function of a bearing shell. The concave curvature 55 is also in the form of a portion of a circle. So that the relatively wide concave curvature 55 has space at the lower wall 53 of the opening 52, the lower wall 53 projects further from the narrow side of the panel 41 than the upper wall 54. At the free end of the lower wall 53 the concave curvature 55 forms an undercut configuration. In the finished laid condition of two panels 40 and 41 that undercut configuration has engaging behind it the



projection 44 of the associated positively engaging profile 42 of the adjacent panel 40. The extent by which the projection 44 engages behind that undercut configuration, that is to say the difference between the thickest location of the free end of the lower wall 53 and the thickness of the lower wall 53 at the deepest point of the concave curvature 55, is such that there is a good compromise between hinged flexibility of the two panels 40 and 41 and a good hold to prevent the positively engaging profiles 42 and 43 from being pulled apart in the plane in which the panels are laid.

10 The fastening system of the state of the art shown in Figures 14, 15 and 16 of utility model No G 79 28 703 U1 has in comparison therewith a considerably greater degree of undercut. That affords extremely stiff connecting locations which give rise to high levels of notch stress due to the loading involved on an irregular base U.

15 The inside of the upper wall 54 of the opening 52 of the panel 41 is arranged in accordance with the illustrated embodiment parallel to the base U in the laid condition.

The lower wall 53 of the opening 52 of the panel 41, which is towards the base, has on its inside an inclined removal of material 56 which extends to the free end of the lower wall 53. By virtue of that arrangement the wall thickness of the wall 53 becomes increasingly thinner to the free end of the wall 53. In the illustrated embodiment the removal of material 56 adjoins the one end of the concave curvature 55.

20 As can be seen from Figure 7 the projection 44 of the panel 40 and the opening 52 of the panel 41 form a common hinge G. The removal of material 51 as discussed in relation to Figure 6 at the top side of the projection 44 of the panel 40 and the removal of material 56 at the lower wall 53 of the opening 52 of the panel 41, in the laid condition of the panels 40 and 41, afford free spaces 57 and 58 respectively for movement, which permit rotary movement for the hinge G in a small angular range.

30 In the laid condition the short straight portion 50 of the top side of the projection 44 of the panel 40 is in contact with the inside of the upper wall 54 of the opening 52 of the panel 41. In addition the convex curvature

45 of the projection 44 bears against the concave curvature 55 of the lower wall 53 of the recess 52 of the panel 41.

The lateral join abutting surfaces 49 and 39, which are towards the top side, of two connected panels 40 and 41 always bear against each other in well-defined fashion. In practice simultaneous exact contact of the convex curvature 45 of the projection 44 of the panel 40 against the concave curvature 55 of the opening 52 of the panel 41 is not possible. The result of manufacturing tolerances would be either that the join abutting surfaces 49 and 39 bear exactly one against each other or the convex curvature 45 bears exactly against the concave curvature 55. In practice the positively engaging profiles 42 and 43 are therefore so designed that the join abutting surfaces 49 and 39 always bear exactly against each other and the convex curvature 45 and the concave curvature 55 cannot be moved sufficiently far one into the other for exact contact. As however the manufacturing tolerances are of the order of magnitude of hundredths of a millimetre the convex curvature 45 and the concave curvature 55 also bear snugly virtually one against the other.

Panels 40 and 41 with the described complementary positively engaging profiles 42 and 43 can be fixed to each other in various ways. As shown in Figure 8 a panel 41 with an opening 52 has already been laid while a further panel 40 with a complementary projection 44 is inserted in an inclined position in the direction indicated by the arrow P into the opening 52 in the panel 41. Thereafter the panel 40 is rotated about the common centre point K of the portion of the circle of the convex curvature 45 of the projection 44 and the concave curvature 55 of the opening 52 until the panel 40 rests on the base U.

A further kind of join between the panels 40 and 41 is shown in Figure 9, whereby the panel 41 with an opening 52 is laid and a further panel 40 with a projection 44 is displaced in the plane of laying of the panels and perpendicularly to the positively engaging profiles 42 and 43 in the direction indicated by the arrow P until the walls 53 and 54 of the opening 52 of the panel 51 elastically expand a little and the convex curvature 45 of the projection 44 has moved beyond the undercut

configuration at the front end of the concave curvature 55 of the lower wall 53 and the definitive laying position is reached.

The latter kind of join is preferably used for the short narrow sides of the panels 40 and 41 when they are provided with the same  
5 complementary positively engaging profiles 42 and 43 as the long narrow sides of the panels 40 and 41.

Figure 10 shows the fastening system in use. The panels 40 and 41 are lying on an irregular base U. The panel 40 with the positively engaging profile 42 is loaded by a force F on its top side. As a result the narrow side  
10 of the panel 40 with the positively engaging profile 42 has been lifted. The positively engaging profile 43 of the panel 41, which is connected to the positively engaging profile 42, has also been lifted. Due to the hinge G, there is a bend or kink between the two panels 40 and 41. The free spaces 57 and 58 for movement afford space for the rotational motion of the hinge  
15 G. The hinge G which is formed from both panels 40 and 41 has been moved upwardly a distance out of the plane in which the panels are laid. The free space 57 for motion has been completely used up for the rotary movement so that the top side of the projection 44 of the panel 40 bears in the region of the removal of material 51 against the inside of the wall 54 of  
20 the panel 41. The connecting location is flexible in itself and does not impose any unnecessary flexural loading such as to cause material fatigue, on the positively engaging profiles 42 and 43 involved here.

The damage which occurs early in the case of positively engaging profiles in accordance with the state of the art, due to breakage of the  
25 projection or the walls of the positively engaging profiles, is thus avoided.

A further advantage is afforded in terms of a hinge movement as indicated in Figure 10. This is that the two panels 40 and 41 drop back into their laying plane again due to their own weight, after having been relieved of load. Slight elastic deformation of the walls 53 and 54 of the recess 52  
30 also occurs in that situation. That elastic deformation promotes the panels 40 and 41 in falling back into their laying plane. Only very slight elastic deformation occurs because the pivot point of the hinge G which is

established by the curvatures 45 and 55 in the form of portions of a circle is within the cross-section of the projection 44 of the panel 40.

Figure 11 shows a hinge movement of two laid panels 40 and 41 in opposite directions of rotation. The panels 40 and 41 which are laid on an irregular base U are bent downwardly. The structure is such that, upon bending of the connecting location out of the plane in which the panels are laid, towards the base U, markedly greater elastic deformation of the lower wall 53 of the opening 52 occurs than in the event of bending upwardly out of the plane in which the panels are laid. The purpose of this measure is that the downwardly bent panels 40 and 41 cannot return to their laying plane again due to their own weight, after relief of the load thereon. The greater elastic deformation of the lower wall 53 of the opening 52 however produces a stressing force which, after the relief of load, immediately moves the panels 40 and 41 resiliently back into their laying plane again.

The described positively engaging profiles 42 and 43 in the present case are formed integrally at the narrow sides of the panels 40 and 41. That is preferably effected by a so-called formatting operation in which in one pass the positively engaging profiles are milled with a plurality of milling tools which are arranged one behind the other. The panels 40 and 41 of the described embodiment substantially comprise an MDF board of a thickness of 8 mm. The MDF board is coated at its top side to be wear-resistant and decoratively. Provided at the underside thereof is a so-called counter-pull layer which compensates for the inherent stresses caused by the coating on the top side.

Finally Figure 12 shows two panels 40 and 41 in the laid condition, using a fastening system with a filler 60 which hardens in a soft-elastic fashion. In this case the free spaces 57 and 58 for movement of the hinge G also serve as a kind of adhesive pocket into which a soft-elastic filler 60 is introduced. In addition the join 61 at the top side is closed with the filler 60 so that no moisture and no dirt can penetrate therein. In addition the bottom 62 of the recess 52 is provided with the filler 60.

The filler 60 further provides that, in the bent condition of two panels 40 and 41, the filler 60 which is deformed in itself, by virtue of the inherent

spring action thereof, is involved in returning the panels 40 and 41 to the plane in which they are laid.

## Panel and panel fastening system

List of references

- 1 floor covering
- 2 fastening system
- 3 panel
- 4 panel
- 4a retaining profile
- 4b retaining profile
- 4c hook element
- 4d hook element
- 4e leg
- 4f hook projection
- 5 panel
- 5b retaining profile
- 5e leg
- 5f hook projection
- 5g retaining surface
- 5h end
- 6 panel
- 7 underside
- 8 top side
- 9 top side
- 10 inside surface
- 11 opening
- 12 adhesive pocket
- 13 inside surface
- 14 end
- 20 retaining profile
- 21 retaining profile
- 22 panel
- 23 panel
- 24 hook element
- 25 hook element
- 26 leg
- 27 leg
- 28 hook projection
- 29 hook projection
- 30 end
- 31 detent element
- 32 recess
- 33 retaining surface
- 34 retaining surface
- 35 end
- 36 detent element
- 37 recess

39 join abutting surface  
40 panel  
41 panel  
42 positively engaging profile  
43 positively engaging profile  
44 projection  
45 convex curvature  
46 part of the narrow side  
47 part of the narrow side  
48 top edge  
49 join abutting surface  
50 portion of 44  
51 removal of material  
52 opening  
53 lower wall  
54 upper wall  
55 concave curvature  
56 removal of material  
57 free space for movement  
58 free space for movement  
60 filler  
G hinge  
L1 clearance  
L2 clearance  
P direction of arrow  
U base